BINDURA UNIVERSITY OF SCIENCE EDUCATION MT505

MASTER OF SCIENCE EDUCATION

OPERATIONS RESEARCH

JAN 2025

Time : 3 hours

Candidates should attempt at most FOUR questions. Each question should start on a fresh page.

A1. (a) Define the following terms as used in solving linear programming problems:

(i) feasible region, [2]

(ii) optimal solution. [2]

(b) Distinguish between slack variable and surplus variable. [3]

(c) Michael is taking an exam in order to become a volunteer firefighter. The exam has 10 essay questions and 50 short questions. He has 90 minutes to take the exam. The essay questions are worth 20 points each and the short questions are worth 5 points each. An essay question takes 10 minutes to answer and a short question takes 2 minutes. Michael must do at least 3 essay questions and at least 10 short questions. Michael knows the material well enough to get full points on all questions he attempts and wants to maximize the number of points he will get.

Let x denote the number of short questions that Michael will attempt and let y denote the number of essay questions that Michael will attempt.

(i) Write down the constraints and objective function in terms of x and y, [6]

(ii) Use the graphical technique to find combination of x and y which will allow Michael to gain the maximum number of points possible. [10]

(iii) Hence, find the maximum number of points obtained. [2]

A2. A manufacturer has production facilities for assembling two different types of television sets. These facilities can be used to assemble both black and white and coloured sets. At the present time, the firm is producing only one model of each type of set. The black and white set contributes \$150 towards profit while a coloured set contributes \$450 towards profit. The number of coloured television sets manufactured everyday cannot exceed 50 as the number of coloured picture tubes available everyday is 50. Each black and white set requires 6-man hours of chassis assembly time, whereas each coloured set requires 18 man hours. The daily available man hours for chassis assembly line is 1800. A black and white set must spend one man hour on the set assembly line, whereas a coloured set must spend 1.6 man hours on the assembly line. The daily available man hours on this line is 240. Ablack and white television requires 0.5 man hours of testing and final inspection whereas a coloured set requires 2 man hours. The total available man hours per day for testing and inspection is 162.

(a) Formulate an LP model so that profit is maximized, [5]

(b) Solve the problem using simplex method and write down the optimal solution and the profit. [20]

A3. Soltex Private Ltd produces electric pumps in three locations: Mutare, Rusape, and Nyanga. Production capacities for the three plants over the past three months are as follows:

Origin	Plant	Production Capacity(units)
1	Mutare	4000
2	Rusape	5000
3	Nyanga	1500
	Total	10500

The firm distributes it's pumps to 4 distribution centres in Bulawayo, Gwanda, Gweru, and Lupane. 3 months forecast of demand is as follows:

Destination	Distribution Centre	Demand Forecast(units)
1	Bulawayo	5000
2	Gweru	3000
3	Gwanda	1000
4	Lupane	1500
	Total	10500

The cost for each unit transported from each source to destination is as follows:

DESTINATION				
Origin	Bulawayo	Gweru	Gwanda	Lupane
Mutare	3	2	7	6
Rusape	7	5	2	3
Nyanga	2	5	4	5

Management would like to determine how much of it's products should be transported from each plant to each distribution centre at minimum total transportation cost.

(a) Develop an LP model that minimizes the transportation cost, [7]

(b) Find the initial basic feasible solution using

(i) The North West Corner method, [3]

(ii) The Vogel's method [3]

(c) Use the transportation Simplex Algorithm to find the optimal solution. [12]

A4. (a) Roy has four machines and four jobs to be completed. Each machine must be assigned to complete one job. The time required to set up each machine for completing each job is shown in the table below. Roy wants to minimize the total setting time needed to complete the four jobs.

	Time(hours)			
	Job 1	Job 2	Job 3	Job 4
Machine 1	5	7	11	6
Machine 2	8	5	9	6
Machine 3	4	7	10	7
Machine 4	10	4	8	3

To minimize the setup time, which machine should be assigned to each of the jobs? [15]

(b) In preparation for the winter season, a clothing company is manufacturing hats, scarf, insulated coats and gloves. All products are manufactured in four different departments: cutting, insulating, sewing and packaging. The company has received firm orders for it's products. The contract stipulates a penalty for undelivered items. The table below provides the data for the situation.

	TIME PER UNITS(hr)				
DEPARTMENT	Hats	Scarf 2	Coat 3	Gloves 4	Capacity(hr)
Cutting	0.3	0.3	0.25	0.15	1000
Insulating	0.25	0.35	0.3	0.1	1000
Sewing	0.45	0.5	0.4	0.22	1000
Packaging	0.15	0.15	0.1	0.05	1000
Demand	800	750	600	500	
Unit Profit	\$30	\$40	\$20	\$10	
Unit Penalty	\$15	\$20	\$10	\$8	

Develop an LP model to determine an optimal production plan for the company. [10]

A5. (a) Two inventory policies have been suggested by the purchasing department of a company.
Policy 1: Order 150 units. The reorder point is 50 units and the time between placing and receiving an order is 10 days.

Policy 2: Order 200 units. The reorder point is 75 units and the time between placing and receiving an order is 15 days.
The setup cost per order is \$20, and the holding cost per unit inventory per day is \$0.02

(i) Which of the two policies should the company adopt? [5]

(ii) If you were in charge of devising an inventory policy for the company, what would you recommend assuming that the supplier requires a lead time of 23 days? [5]

(b) A newspaper stand purchases newspapers for 25 cents and sells them for 30 cents per newspaper (because the dealer buys papers at retail price to satisfy shortages). The holding cost is 0.5 cents. The demand distribution is a uniform distribution between 200 and 300, that is $U(200, 300)$. Find the optimal number of papers to buy. [7]

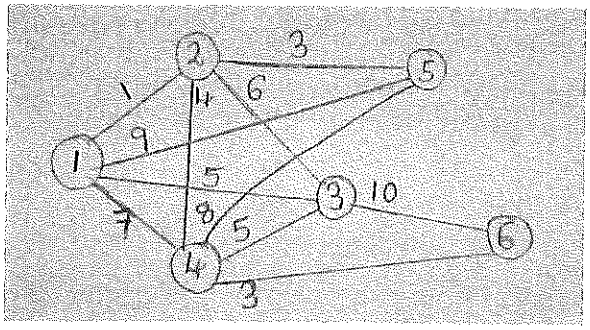
[Hint: Treat c=25 and p as penalty that is p=30]

A6. (a) Define the following terms:

(i) inventory, [2]

(ii) holding cost. [2]

(b) Telekom TV cable company is in the process of providing cable service to six new housing development areas. The diagram below shows the possible TV linkages among the six areas. The cable (km) are shown on each arc.



(i) Determine the most economical cable network. [6]

(ii) Determine the minimum spanning tree of the above network under each of the following:

(a) Nodes 5 and 6 are linked by a 5km cable, [5]

(b) Nodes 2 and 5 cannot be linked, [5]

(c) Nodes 2 and 6 are linked by a 6km cable. [5]

END OF QUESTION PAPER